# AQUATIC MACROINVERTEBRATE BIOTIC INTEGRITY AS A VITAL SIGN FOR MONITORING PARK CONDITIONS: METRIC SELECTION AND BASELINE DATA FOR THE NORTHERN GREAT PLAINS NETWORK

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INTRODUCTION - The National Park Service I&M program seeks to define vital signs for the purpose of monitoring and managing park condition throughout the United States. Vital signs are defined as those ecological attributes which are both sensitive to changes in the park environment and also relevant to the management of park resources. Aquatic macroinvertebrate biotic integrity ranks high as one potential vital sign of park condition. However, metrics appropriate to evaluate macroinvertebrate biotic integrity are likely to be different regionally and among different aquatic system types. The objectives of this effort were to (1) characterize aquatic macroinvertebrate communities within bison watering impoundments, springs, small-medium sized streams and large rivers of the Northern Great Plains Network (NGPN) and (2) identify those metrics which are responsive to disturbance gradients and able to discriminate among sites.

Ranks of NGPN Candidate Vital Signs
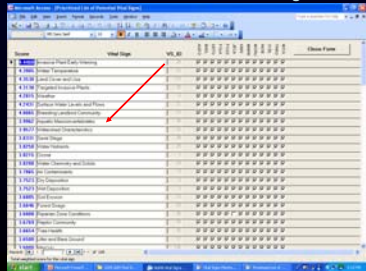
METHODS — Modified EMAP Western Pilot protocols were used to sample and process aquatic macroinvertebrates from each of 58 aquatic sites during the 2004 and 2005 growing seasons. Samples were collected from 10 large rivers, 2 irrigation canals, 12 streams, 8 springs and 5 bison impoundments. Macroinvertebrates were sorted and identified to the lowest practical level and counts of individuals and taxa were applied toward calculation of metrics to describe community conditions within each site. Metric responsiveness to existing disturbance gradients was evaluated with correlation and regression analysis using invertebrate, channel habitat, riparian condition and water chemistry data. Metric site discriminatory power was evaluated using the Kruskal-Wallis ANOVA F-statistic. Final metric lists for each system type included measures for characterizing community composition, diversity, feeding guilds, habit use guilds and pollution tolerance.

Metric Selection Process:

1) Between 60-70 community metrics were calculated from raw invertebrate counts for each aquatic system type (Bison Impoundment, Spring, Stream, River)
2) Kruskal-Wallis F statistics were calculated to compare among versus within site variability for each metric and aquatic system type (DP)
3) Metrics were ranked by DP within their descriptive groups (Composition, Diversity, Feeding Guild, Habit Guild, Tolerance)
4) Obvious redundancy among highly ranking metrics was eliminated by selecting that metric with the highest DP and/or greatest data range
5) Metrics with a high percentage (>25%) of undefined values were eliminated (e.g., ratio metrics)
6) Metrics with a greater range of values were selected over those with a narrower range of values
7) Metrics of greater utility to partners were selected over those not used by partners
8) Metrics exhibiting significant relationships with measures of chemical, habitat and landscape disturbance were selected over those without relationships

Metric Selections by System
Summary Statistics and Discriminatory Power

Impoundment Metrics	Min	25th	50th	75th	Max	DP (p<0.05)
			Percentile			
Percent Dominant	27.8	34.0	46.9	61.5	100	3.45
Percent Chironomidae	0.0	0.0	19.6	55.2	78.9	3.13
Non-Insecta Richness	0	0.8	1	2	4	(8.01)
Margalef Index	0.00	1.20	1.62	2.12	2.77	(4.99)
Chironomidae Richness	0	0	2	3	4	(4.11)
Shredder Richness	0	0	1	1.3	3	3.60
Feeding Guild H'	0.00	0.58	0.93	1.08	1.18	2.77
Clinger Richness	0	0	1	1.3	3	3.60
Habit Evenness	0.00	0.41	0.62	0.80	0.93	2.94
Tolerant Richness	0	3	4	5	8	3.58

Spring Metrics	Min	25th	50th	75th	Max	DP (p<0.05)
			Percentile			
Percent Chironomidae	0.0	0.0	3.2	45.5	100	(10.60)
Percent EPT	0.0	2.3	16.7	46.2	97.1	(3.37)
EPT Richness	0	1	1	2	4	2.44
Chironomidae Richness	0	0	1	2	4	2.27
Percent Shredders	0.0	0.0	9.1	38.9	85.7	(6.11)
Percent Collector-gatherer	14.3	27.3	36.4	54.5	100.0	(2.75)
Percent Predator	0.0	0.0	6.5	45.5	78.6	(2.75)
Percent Climber	0.0	0.0	0.0	16.1	85.7	(3.37)
Percent Glider	0.0	0.0	0.0	7.0	41.7	2.58
Modified HBI	2.0	4.9	5.5	6.6	8.9	(3.93)

Stream Metrics	Min	25th	50th	75th	Max	DP (p<0.05)
			Percentile			
Percent Non-Insecta	0.0	2.9	10.3	30.0	100	(3.94)
EPT:Chironomidae	0.00	0.41	0.81	0.97	1.00	(5.31)
EPT Richness	0	2	3	5	11	(2.89)
Chironomidae Richness	0	1.5	3	5	14	(3.06)
Shannon H'	0.00	1.40	1.85	2.28	2.80	(3.15)
Predator Richness	0	2	4	6.5	14	(4.60)
Feeding Guild H'	0.00	0.48	0.93	1.07	1.29	(2.09)
Percent Sprawler	0.0	3.3	12.5	24.6	66.1	(3.15)
Habit Guild H'	0.00	0.89	1.14	1.32	1.54	(2.42)
Modified HBI	3.07	4.61	5.05	6.30	9.60	(5.28)

River Metrics	Min	25th	50th	75th	Max	DP (p<0.05)
			Percentile			
Percent EPT	0.0	2.0	24.5	55.0	93.5	(3.98)
Percent Chironomidae	0.0	2.0	9.6	34.0	100	(2.95)
Total Richness	2	5	9	16	26	(3.60)
Non-Insecta Richness	0	1	2	3	6	(2.29)
EPT Richness	0	1	2	4.5	10	(5.09)
Collector-Filterer Richness	0	0	1	2.5	6	(2.90)
Collector-Gatherer Richness	1	2	4	7	13	(2.81)
Clinger Richness	0	1	2	4	10	(4.70)
Swimmer Richness	0	1	2	4	7	(2.83)
Modified HBI	2.92	4.65	5.23	6.24	9.00	(2.73)

Metric Relationships to Disturbance Gradients

Streams: $R^2 = 0.49$, $p < 0.001$

Streams: $R^2 = 0.26$, $p < 0.001$

Springs: $R^2 = 0.46$, $P < 0.001$

Springs: $R^2 = 0.20$, $p = 0.018$

Rivers Threshold
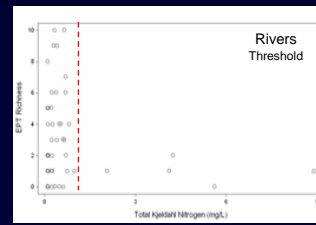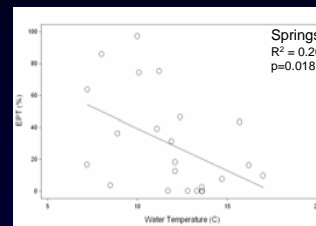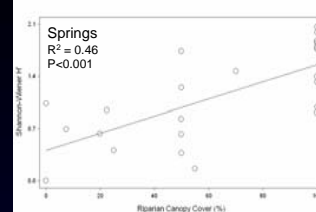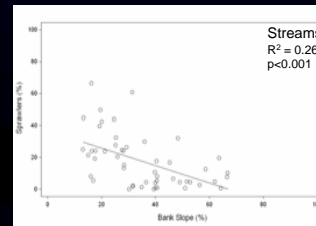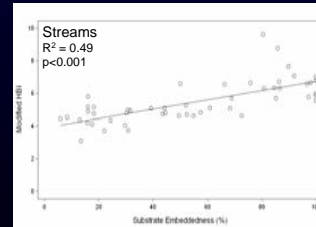
Utilization of Stream & River Metrics by Partner Agencies

Stream & River Metrics	ND	NE	SD	WY	USEPA	USGS
			Partners			
Percent Non-Insecta	NA	-	NA	X	X	-
EPT:Chironomidae	NA	-	NA	X	-	X
EPT Richness	NA	X	NA	X	X	-
Chironomidae Richness	NA	-	NA	X	-	-
Shannon-Wiener H'	NA	-	NA	X	-	X
Predator Richness	NA	-	NA	X	-	-
Feeding Guild H'	NA	-	NA	-	-	-
Percent Sprawlers	NA	-	NA	X	-	-
Habit Guild H'	NA	-	NA	-	-	-
Modified HBI	NA	X	NA	X	-	-
Percent EPT	NA	-	NA	X	X	-
Percent Chironomidae	NA	-	NA	X	-	-
Total Richness	NA	X	NA	X	-	X
Non-Insecta Richness	NA	-	NA	X	-	-
Collector-Filterer Richness	NA	-	NA	X	X	-
Swimmer Richness	NA	-	NA	X	X	-
Collector-Gatherer Richness	NA	-	NA	X	-	-
Clinger Richness	NA	-	NA	X	-	-

NA – macroinvertebrate metrics not yet selected by partnering agency
X – metrics utilized by partnering agency

RESULTS & DISCUSSION — Aquatic macroinvertebrates are utilized widely to monitor aquatic habitat and water quality conditions. These organisms are highly sensitive to changing conditions, present in all aquatic habitats and exhibit limited ability to move away from a disturbed area. Metrics are measurements taken to characterize the macroinvertebrate community. As these communities change from one aquatic habitat type to another and from region to region, it is necessary to carefully select those metrics which might provide the best indication of change. In addition, aquatic environments within the park networks may provide the best reference conditions against which to monitor and manage aquatic resources outside of park boundaries. Thus, development of baseline macroinvertebrate monitoring data would benefit state and federal partners.

We defined different optimal metric sets for bison impoundments, springs, streams and rivers of the NGPN. Many metrics varied significantly among sites within a habitat type. This was not surprising as many of our sites were distributed among several ecoregions.

Despite many site differences, fewer than half of the metrics demonstrated significant relationships with water quality, habitat and riparian gradients. Metric sensitivity to these changing conditions is important for detection of future change and must be considered in the selection process.

Overlap exists among metrics selected from this analysis and those selected by state and other federal partners. The broad suite of metrics utilized by Wyoming ensures that much of the data collected from Wyoming park sites would be useful to that agency. Recent EPA efforts in Montana have also generated prairie stream metric lists which include representatives of those selected in this effort. Metric overlap and use of consistent sampling methodology would provide data meeting the needs of the NPS I&M Program and facilitate water resource monitoring and data sharing with other monitoring groups.